TCEQ, Air Permits Division
AERMOD Implementation Group
December 15, 2003
1 - 5 pm
Renaissance Hotel, 9721 Arboretum Blvd., Austin, Texas

Minutes

I. Opening Remarks . . . . Dale Beebe Farrow, P.E.

The purpose of the meeting was to share information; identify implementation issues; propose implementation options; solicit feedback from stakeholders; and form the basis for an implementation plan.

II. Background . . . . Dom Ruggeri, P.E.

A. History of AERMOD (**A**merican Meteorological Society/**E**nvironmental Protection Agency **R**egulatory **Mod**el). Since the early 1980's, the Environmental Protection Agency (EPA) has acknowledged a need for a state-of-the-art air quality regulatory model based on planetary boundary layer (PBL) turbulence structure, similarity (scaling) and concepts. EPA's focus since that time was on a replacement for the Industrial Source Complex, Version 3 (ISC3) model. ISC3 contains several outdated concepts and practices, such as the simplified dispersion scheme based on the **P**asquill-**G**ifford-**T**urner (PGT) approach to characterize atmospheric turbulence using stability classes which was initially developed for rural low-level sources and does not always lead to reasonable predictions for all source types and locations. Other factors such as the mechanism to address plume penetration of upper-air inversions, the treatment of complex terrain with screening algorithms, no treatment for intermediate terrain, and limitations of downwash algorithms were also a concern.

B. Current Status. The EPA originally proposed AERMOD as a preferred regulatory model in April 2000. At the time of promulgation, AERMOD did not contain all of the capabilities that most customers depended upon in ISC3. During the past three years, EPA decided to enhance the initial version of AERMOD to address comments made by peer reviewers and various customers related to model features, downwash, and deposition. In September 2003, EPA provided notice of intent to replace ISC3 with a version of AERMOD that would include the Plume Rise Enhancements (PRIME) algorithms. Deposition was added to the model in November, 2003. The EPA has indicated that promulgation of AERMOD may be delayed until the spring of 2004.

C. Issues. The primary issues that need to be addressed before we can develop an implementation plan relate to the mandatory use date for the model and whether the TCEQ should use the model for both state and federal permit reviews; the retention of the ISC3 model and the current screening model (SCREEN3); the development of meteorological data sets; and the type and frequency of training and feedback.

III. AERMOD and Required Supporting Programs . . . . Dom Ruggeri, P.E.

A. Dispersion Model (AERMOD). The following information was taken from EPA documents which are available on the Support Center for Regulatory Models (SCRAM) web site at http://www.epa.gov/scram001

USEPA, "Comparison of Regulatory Design Concentrations: AERMOD vs. ISCST3, CTDMPLUS, ISC-PRIME," EPA Report No. EPA-454/R-03-002, July 2003

USEPA, "AERMOD: Latest Features and Evaluation Results," EPA Report No. EPA-454/R-03-003, July 2003, and

USEPA, "AERMOD: Description of Model Formulation (Version 02222), EPA Report No. EPA 454/R-02-002d, October 31, 2002.

1. AERMOD incorporates state-of-the-art boundary layer theory, convective dispersion, plume rise formulations, and complex terrain/plume interactions. AERMOD is a steady-state model that contains new or improved algorithms for: 1) dispersion in both the convective and stable boundary layers; 2) plume rise and buoyancy; 3) plume penetration into elevated inversions; 4) treatment of elevated, near-surface, and surface level sources; 5) computation of vertical profiles of wind, turbulence, and temperature; 6) the treatment of receptors on all types of terrain (from the surface up to and above the plume height); and 7) plume rise model enhancements for treatment of downwash.

2. A key difference between the two models is the replacement of the PGT system with the use of PBL and similarity theory to determine dispersion coefficients. The PBL is a general term used to describe the turbulent air layer next to the earth's surface that is controlled primarily by surface heating and friction. The PBL typically ranges from a few hundred meters in depth at night to 1 - 2 kilometers during the day. There are multiple layers within the PBL. For AERMOD, we are primarily concerned with the convective boundary layer (CBL) and the stable boundary layer (SBL). The CBL is a mixed layer that is dominated by buoyant turbulence. The SBL forms when the surface is cooler than the air above it.

3. AERMOD constructs vertical profiles of required meteorological variables based on measurements and extrapolations of those measurements using similarity (scaling) relationships. Vertical profiles of wind speed, wind direction, turbulence, temperature, and temperature gradient are estimated using all available meteorological observations.

4. There is no screening tool for AERMOD yet. EPA is working on AERSCREEN; however, from our review so far, it appears that SCREEN3 will provide conservative concentration estimates for most source types.

5. AERMOD includes plume meander. Therefore, when we use AERMOD we won't be able to use the fugitive reduction factor that we developed for ISC3.

6. There are no "virtual points" used for volume sources. AERMOD adds ambient turbulence to the initial dispersion identified by the model user.

7. AERMOD requires input from three stand-alone preprocessors AERMAP, AERMET, and BPIPPRM.

B. Terrain Data Preprocessor (AERMAP). The **AER**MOD **map**ping program (AERMAP) is a stand-alone terrain pre-processor which is used to characterize terrain and to generate receptor grids for AERMOD. Input data include receptor terrain elevation data. The terrain data may be in the form of digital terrain data that is available from the U.S. Geological Survey. For each receptor, the output includes a location and height scale, which is an elevation used for the computation of air flow around and over hills. AERMAP uses gridded terrain data to calculate a representative terrain-influence height, also referred to as the terrain height scale for each receptor location.

C. Meteorological Preprocessor (AERMET) The **AER**MOD **met**eorological preprocessor (AERMET) is a stand-alone preprocessor program which provides AERMOD with the information it needs to construct vertical profiles of required meteorological variables based on measurements and extrapolations of those measurements using similarity relationships. Input data can come from hourly cloud cover observations, surface meteorological observations and twice-a-day upper air soundings. Output includes surface meteorological observations and parameters and vertical profiles of several atmospheric parameters.

The user provides surface characteristics in the form of albedo, surface roughness and Bowen ratio which AERMET uses to calculate the PBL parameters: friction velocity, Monin-Obukhov length, convective velocity scale, temperature scale, mixing height, and surface heat flux. AERMOD uses these parameters to calculate vertical profiles of wind speed, lateral and vertical turbulent fluctuations, potential temperature gradient, and potential temperature.

The surface characteristics are developed for the application site. EPA assumes that the application site is the meteorological measurement site. The meteorological measurement site must either be at the application site or judged to be representative of the conditions at the application site. The model user must keep in mind that there is no practical way to detail albedo, Bowen ratio, and surface roughness in time or space. Therefore, reasonable representations that generally give representative or conservative results for the controlling sources under evaluation are acceptable.

D. Downwash Building Profile Input Program for the Plume Rise Model Enhancements (BPIPPRM) The **B**uilding **P**rofile **I**nput **P**rogram for the **P**lume **R**ise **M**odel Enhancements (BPIPPRM) is a stand-alone building dimensions preprocessor program. The program generates building height and width parameters for every ten degrees from 10 degrees through 360 degrees. In addition, the program calculates the projected building length along the flow as well as the distance along and across the flow from a stack to the center of the upwind face of a projected building. AERMOD uses these parameters and the PRIME algorithms to calculate the effect of downwash on plume dispersion.

Unlike the downwash process used for ISC, the location of the source on or near the building must be reasonably accurate since the program takes location into account when developing the downwash parameters. The user must take care when developing “conservative” downwash scenarios or when collocating emission points.

IV. California Puff (CALPUFF) Model . . . . Dom Ruggeri, P.E.

A. History of CALPUFF.

1. *Why did we need this model?* The EPA did not have a regulatory model to provide long-range transport predictions. A model was needed to assist federal land managers in the assessment of impacts of air pollutants on Federal Class I and Wilderness areas.

2. CALPUFF is a non-steady state model that gained support for promulgation as a regulatory model primarily to address long-range prediction shortfalls linked with steady-state models, such as the ISC3 model, that were identified by the Interagency Workgroup on Air Quality Modeling (IWAQM).

B. Current Status. EPA adopted the CALPUFF model on April 15, 2003. This model is preferred for assessing transport of pollutants beyond 50 kilometers and their impact on Class I areas. In addition, the model is recommended when transport involves complex wind flow regimes such as those encountered in coastal areas or in areas with non-homogenous terrain such as mountains, hills, and valleys. The model can be used now but must be used after April 15, 2004.

V. TCEQ AERMOD/AERMET Generic Sensitivity Study . . . . Robert Opiela

A. AERMOD/AERMET Generic Sensitivity Study (Part 1)

The purpose of this part of the study was to determine model sensitivity to surface parameters (B = Bowen ratio; r = albedo; and z_0 = surface roughness length). The approach taken was as follows:

- Select three different values (high, medium, and low) for B, r, and z_0, resulting in 27 different combinations; therefore 27 different meteorological data sets.

- Select three source heights: high, medium, and low.

- Use sources with neutrally buoyant exhaust parameters.

- Align receptors with wind directions (polar grid). Wind directions were every 10 degrees from 10 degrees through 360 degrees.

An analysis was performed to determine if there was any correlation of changes in parameter value to changes in modeling results considering source height, source-to-receptor distance, and averaging time. The TCEQ concluded the results were most affected by changes in roughness length. Changes in Bowen ratio and albedo did not affect results in a predictable or significant way.

B. Part 2.

The purpose of this part of the study was to determine how results vary due to changes in surface parameters and observed meteorology. The approach taken was the same as in Part 1, with one exception. The TCEQ compared results from two dissimilar areas: Houston and El Paso. The analysis consisted of determining any correlation of results between meteorology from two dissimilar areas considering source height, source to receptor distance, and averaging time. The analysis showed that the 1-hour and annual results between the two dissimilar areas correlated very well for all sources and distances. The 24-hour results correlated well only at the greatest distances, beyond 900 meters. It was concluded the results were affected mainly by surface parameter selections and not by measured meteorology. The differences in diurnal wind patterns best explained the lack of a correlation for the 24-hour results.

C. Part 3.

The purpose of this part of the study was to compare ISC3 results to AERMOD results without downwash. The approach taken was as follows:

- Use default values for B and r. These values were determined from our experience with the risk assessments for hazardous waste incinerators.
- develop ten scenarios with roughness length 0.1 - 1.0 meters, therefore ten meteorological data sets for AERMOD and one met set for ISC.
- Evaluate results from ISC3 using both Rural and Urban dispersion coefficients

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- Select three source heights: high, medium, and low.
- Use sources with neutrally buoyant exhaust parameters.
- Align receptors with wind directions (polar grid). Wind directions were every 10 degrees from 10 degrees through 360 degrees.

Since there were ten sets of results for each averaging time, only general conclusions regarding the trends in results could be made. For a 1-hour averaging period, ISC3 generally predicted higher concentrations than AERMOD. For AERMOD results, in general, larger roughness lengths led to lower predicted concentrations. For a 24-hour averaging period, ISC3 Urban generally predicted the overall highest concentrations. For AERMOD results, in general, larger roughness lengths led to higher predicted concentrations for lower sources (< 40 meters). For an annual averaging period, ISC3 Urban generally predicted the overall highest concentrations. For AERMOD results, in general, larger roughness lengths led to higher predicted concentrations. In addition, the lower a source the closer the maximum was to the source.

D. Part 4.

The purpose of this part of the analysis was to compare ISC-PRIME results to AERMOD results with downwash. The approach taken was the same as Part 3 with the following exceptions:

- Building height = 1L; Building width = 3L; L = 10 meters.

- Source and building centerline were always aligned with wind direction.

- Source placed from 3L upwind to 3L downwind of the building.

Since there were 36 sets of results for each averaging time, only general conclusions regarding the trends in results could be made. For all averaging periods ISC-PRIME generally predicted the highest maximums with the exception of sources much higher than the building and upwind of the building. ISC-PRIME also generally predicted higher concentrations than AERMOD past the wake region. For AERMOD results and for all averaging periods, larger roughness lengths generally led to lower predicted concentrations. For shorter sources, locations downwind of the building led to higher predicted concentrations than locations upwind of the building. For taller sources, locations upwind of the building led to higher predicted concentrations than locations downwind of the building.

VI. TCEQ AERMOD/AERMET Source-Specific Sensitivity Study . . . Dom Ruggeri, P.E.

A. The analyses. The TCEQ staff used AERMOD to determine concentrations for several projects that had been previously evaluated and permitted using ISC or ISC-PRIME. Source parameters varied but included neutral, moderate, and strong buoyancy and momentum fluxes. While the primary objective was to determine source-specific model sensitivity, the secondary objective was to give staff experience with the AERMOD in real-world scenarios.

B. Findings. The preliminary finding is that AERMOD results are highly dependent on the relationship between source parameters, downwash parameters, and surface characteristics. For the limited review we conducted, ISC-predicted concentrations were generally higher than those predicted by AERMOD. While some general statements can be made, each technical review will be case by case.

1. Surface characteristics. The model is most sensitive to surface roughness for all source types. While model output varies with changes in albedo and Bowen ratio, the changes are within a few percent while changes in surface roughness can result in orders of magnitude changes. It must be noted that mixing and matching albedo, Bowen ratio, and surface roughness can result in significantly different results for different averaging periods. The user must take care to use reasonable values for all surface characteristics as the use of characteristics that “can’t occur” or would be “unlikely to occur” may result in “unacceptable” or “nonrepresentative predictions.

2. Controlling source(s). For most multi-source scenarios, it is important to determine the controlling source(s). “Controlling source(s)” is defined as the source(s) that is likely to cause the highest predicted concentrations. Surface characteristics should be used that are most representative for dispersion of plumes from the controlling source(s).

3. Fugitive sources (little to no buoyancy or momentum flux). Without downwash, the model is highly sensitive to surface roughness. For low-level fugitive sources, the greater the surface roughness, the lower the predicted concentration. When downwash is applied though, concentrations in the near field can be significantly higher than in nondownwash scenarios.

4. Tall, very buoyant sources with large momentum flux. Longer averaging period concentrations may be significantly higher than those obtained using ISC3.

5. Urban option. Use of the urban option can significantly lower concentrations compared to concentrations obtained using AERMOD without the urban option but with the same roughness length.

6. SCREEN3 conversion factors. Staff used the current 1-hour to other averaging period ratios currently used with the SCREEN3 model to convert AERMOD 1-hour concentrations to other averaging periods. The converted concentrations were higher than those predicted by AERMOD. However, since AERMOD predicted higher concentrations than ISC3 for some cases, we may need to increase the conversion factors slightly to ensure that we don't under predict impacts using the SCREEN model.

VII. TCEQ Proposals . . . . Dom Ruggeri, P.E.

A. AERMOD.

1. Require AERMOD after promulgation for both federal and state analyses. This action will ensure consistency for the technical reviews of all air permitting actions as well as protectiveness reviews to support permits-by-rule and standard permits.

2. Retain SCREEN3 as an initial screening tool. Evaluate AERSCREEN when available. This action ensures that applicants and permit reviewers retain a tool that has proved effective at streamlining the technical review process. Some minor modifications must be made to ensure that results from AERMOD will not be higher than those obtained from SCREEN3.

3. Consider replacing the use of volume source representations with multiple point sources or area sources. Since AERMOD will not have a true volume source algorithm, the TCEQ will evaluate the effect of replacing volume source representations with other characterizations.

B. AERMET.

1. Develop standard meteorological data sets. This action will ensure consistency and data quality and streamline the AERMET review process. Multiple data sets will be developed to include a range of surface roughness lengths and default Bowen ratio and albedo percentages. The default values will be based in part on climatological moisture and solar radiation data for the state's ten climate divisions

2. Realign counties with National Weather Service (NWS) climate divisions and available surface and upper-air stations. This action will ensure consistency in the development of the default surface parameters used by AERMET.

3. Consider the use of NWS Automated Surface Observing Stations (ASOS). The use of ASOS would expand the number of surface meteorological stations. The TCEQ will evaluate the effect of including ASOS in the development of standard meteorological data sets.

4. Consider the use of different meteorological data years. The TCEQ will evaluate the need to change the current data years recommended for state and federal permit review.

5. Develop standards for data completeness. The EPA has not proposed any data completeness requirements. This action would ensure that robust data sets are developed and used.

C. AERMAP. Determine if flat terrain can be assumed if the slope is less than 10 percent. EPA's AERMOD process automatically includes an evaluation of terrain and forces the use of United States Geological Survey digital elevation model data. The effect of terrain may not be significant for most locations in the state. Therefore, the TCEQ will evaluate the need to include terrain for all analyses.

VIII. Training . . . . Dom Ruggeri, P.E.

A. Purpose. Develop a training program to

1. Provide general technical knowledge of AERMOD.

2. Recognize validity of inputs and outputs.

3. Find/get necessary data for inputs.

4. Clarify and elaborate on EPA guidance.

B. Timing. Establish a training schedule to

1. Take advantage of the one-year phase-in period.

2. Include abbreviated training at 2004 Environmental Trade Fair.

C. Location.

1. In Austin and other cities in the state if there's interest.

2. Provide all training and documentation on the TCEQ website.

IX. Open Discussion . . . . Dom Ruggeri, P.E.

1Q. No data from wind tunnel studies suggests that cavity receptors are really there. Should we still use Building Profile Input Program (BPIP)-PRIME?

1A. We will use AERMOD and its downwash algorithms until more refined information is obtained and evaluated. Forward any specific information and recommendations to the TCEQ for review.

2Q. For Effects Screening Levels (ESL) modeling, emission rates are often "back calculated" from 2 x ESL, 24 hours of exceedances during the year. How will AERMOD effect this approach?

2A. Use of AERMOD will not change the basic approach to modeling or the protectiveness review process. The new Toxicology Section is evaluating ESLs and will develop technical background documents for each ESL. This review may result in different ESLs, time periods of concern, and the tiered review process. In addition, the Toxicology Section will work with the Air Permits Division to establish a more flexible technical review approach. One concern the TCEQ staff has relates to limited EPA sensitivity studies that suggest that AERMOD annual concentrations will be consistently higher than ISC3 concentrations and that the ratio of AERMOD maximum annual concentrations to hourly concentrations will be greater than 0.08. While the TCEQ staff also saw higher annual concentrations for certain sources, the majority of annual concentrations were lower than those predicted by ISC. We may need to change the way annual ESLs are evaluated (annual ESLs 10% of 1-hour ESL) after more information is gathered during actual model use.

3Q. Are the "watch list" pollutants still closely monitored and should AERMOD be used to predict concentrations for these pollutants?

3A. Yes, we will use AERMOD as a tool to predict concentrations for pollutants on the watch list. Special attention is needed when fixed or mobile monitoring detects elevated concentrations in an area, and the air dispersion model predicts a high concentration in or near the same area. However, if AERMOD suddenly predicts significantly larger concentrations than ISC3 for a small emission increase where sitewide impacts were acceptable before, we may need to develop adjustment factor just as we did before with ISC and low-level fugitives.

4Q. Should we use AERMOD for a benzene increase in Harris county? The permit is currently undergoing technical review.

4A. There's no requirement to switch to AERMOD now. Since we have monitored concentrations to confirm elevated concentrations of benzene in Harris county, modeling results are not as critical as in an area where we don't have monitored concentrations. The overall goal is to lower benzene concentrations. To do this we will evaluate permits requesting increases in benzene using the location of the monitored concentrations, the location of nearby benzene sources, the location of benzene increase, and the overall net effect of the permit.

5Q. Within one year after AERMOD promulgation, will the TCEQ meteorological (met) data sets be available?

5A. Yes, the met data sets will be available before the one-year phase-in period ends. The TCEQ can provide assistance with AERMET until the met data sets are created. AERMOD will be used for both state (1 year of met data) and federal (5 years of met data) reviews.

6Q. If I want to use AERMOD for a certain site, do I have to stick with it in the future?

6A. Yes. And if you want to use AERMOD, you must use AERMOD for all sources and pollutants at that site (no mixing and matching of models). To put it into permitting terms, "no partial modeling."

7Q. What exactly does the one-year time frame mean once AERMOD is promulgated? When the permit is turned in? When the permit application is received by the Permits Administrative Review (PAR) program?

7A. There are many ways to interpret the required use-by date. The simplest: AERMOD must be used for air quality analyses submitted to the TCEQ after the required use-by date. The TCEQ wants to be reasonable and flexible. Therefore, we will consider each project on a case-by-case basis and attempt to minimize the effect of the transition from ISC3 to

AERMOD.

8Q. Is EPA phasing in AERMOD? If I complete a protocol for using a certain model, do I have to use it in the modeling demonstration?

8A. EPA is using the one-year period from promulgation until the required use-by date to phase in AERMOD. Stick with the model you listed in the protocol unless you ask TCEQ to change. The TCEQ will not make you switch in the middle of the protocol-modeling process. Once again, the decision to use AERMOD will be made on a case-by-case basis. If a protocol is submitted a short time before the required use date, the TCEQ will likely ask that AERMOD be used to conduct the modeling demonstration. In addition, we will evaluate whether results from ISC should be more conservative than AERMOD for the controlling sources in the permit application. At some point in the future this question will be moot. The applicant may wish to move forward and use AERMOD even if ISC was preapproved.

9Q. How will ADMT decide surface roughness (z_0)? Will there be low, medium, and high categories?

9A. The ADMT will put together initial roughness grouping estimates (low, medium, and high) and request comment from potential users. The user will need to justify the selection of the category that is most nearly like the area around the application site. More refinement of the roughness categories may be necessary if the "default" selection results in concentrations that are too conservative. For example, if the applicant has a low-level fugitive source with an impact in a certain quadrant and that quadrant could be characterized with a higher surface roughness length, the applicant could refine the z_0 and rerun the model using AERMET input based on the refined z_0.

10Q. How will ADMT prioritize the development of met sets? Will you prioritize based on the order of permit application locations?

10A. All met sets should be available within a few months after the decision is made to develop the met sets. We will start with the areas of the state with the most sources.

11Q. Is the ADMT really considering Automated Surface Observing Station (ASOS) data? Due to monitoring conventions, I am concerned about the increase in the number of calm winds reported by ASOS. For example, I've noticed that there are significantly more calm wind speeds from ASOS as compared to the standard National Weather Service (NWS) data for Baton Rouge, LA.

11A. The ADMT will continue to examine if the technical review process would be improved by using ASOS data. Currently, we cannot use ASOS data in AERMOD since cloud cover data are missing. Please advise ADMT of your experiences using ASOS data.

12Q. Could we use AERMOD for a permit that has a contested-case hearing before formal promulgation?

12A. Yes. EPA has presented sufficient documentation to validate that AERMOD is a more "refined" model than ISC3. There should be no problem with using this model before formal promulgation since there will be no significant changes made to the version of AERMOD we have evaluated.

13Q. Are there any test met sets available for AERMOD?

13A. Yes. ADMT can make these available to you by email.

14Q. The permit reviewer requests that modeling be at the TCEQ 30 days after the modeling request letter is sent. Will there be any leniency for this using AERMOD?

14A. The applicant should start the modeling process as soon as possible for the permit review. While the model is new, the modeling process remains the same. There will always be competing time requirements, but permit timeframe reduction and elimination or prevention of permit backlog is the highest priority within the air permits division.

15A. Are the PRIME algorithms in AERMOD?

15Q. Yes. Use the BPIPPRM preprocessor to develop downwash parameters for AERMOD.

16.Q. Should CALPUFF be used for new source review and prevention of significant deterioration projects with areas of impact greater than 50 kilometers?

16A. At this point in time, unless there is a Class I area involved we do not see the need to use CALPUFF for this scenario. It has been our experience that maximum impacts will occur within distances less than 50 kilometers from the source undergoing permit review.

X. Closing Remarks/Action Items . . . . Dom Ruggeri, P.E.
The TCEQ will develop a list of questions related to implementation plan proposals and solicit comment from this group as well as other interested parties. The TCEQ will establish a location on the Air Permits Division website devoted to AERMOD which will include the questions, responses, and staff evaluation of the responses.

XI. Next Meeting Date . . . . Dom Ruggeri, P.E.
Open. Timing depends on the response to our proposals and final promulgation of AERMOD.

MEETING ATTENDEES

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